Health Outcomes Associated with Self-Reported Vision Impairment in Older Adults

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Structured abstract: *Introduction:* To compare the health status of older adults with and without vision impairment, this study employed a disability framework consisting of four stages, progressing from risk factors; through pathology and impairments that result in declining functioning; and eventually to disability. *Methods:* Data from five rounds (1999 to 2008) of the National Health and Nutrition Examination Study were analyzed. Binary and multinomial logistic regression were used to estimate odds ratios, with 95% confidence intervals reflecting the likelihood of negative health outcomes among persons with self-reported fair and poor vision relative to persons with good vision. *Results:* Fair and poor vision status were associated with negative health outcomes across the four health dimensions. *Discussion:* Disparities in health among vision status groups may originate as a result of limitations in daily activities that could lead to changes in diet, health maintenance, and activity levels. Alternatively, disparities may reflect primary pathologies and conditions that are secondarily related to poor vision status. Longitudinal research is suggested in order to assess the order of key events, and to make a more powerful assertion of causality. *Implications for practitioners:* Comparisons of health outcomes by vision status are important because of the potential to identify points in the disability framework where effective interventions could prevent progression to later stages in the disability process.

Visual impairments (that is, blindness or low vision) in late life are closely related to health and have been associated with a range of health-related outcomes that influence and reflect the well-being of older adults (National Academies of Sciences, Engineering, and Medicine, 2016). Independent studies have associated vision impairment with reduced functional capacity and physical activity levels (Crews & Campbell, 2004), reduced psychosocial well-being (Chia, Mitchell, Rochtchina, Foran, & Wang, 2003), morbidity (Crews & Campbell, 2004) and comorbidity (Crews, Jones, & Kim, 2006), self-rated health (Wang, Mitchell, & Smith, 2000), and even mortality (McCarty, Nanjan, & Taylor, 2001). Researchers have also reported relationships between vision impairment and various health risk factors such as obesity (Capella-McDonnall, 2007), inflammation (Seddon, Gensler, Milton, Klein, & Rifai, 2004), and high cholesterol levels (Curcio, Millican, Bailey, & Kruth,

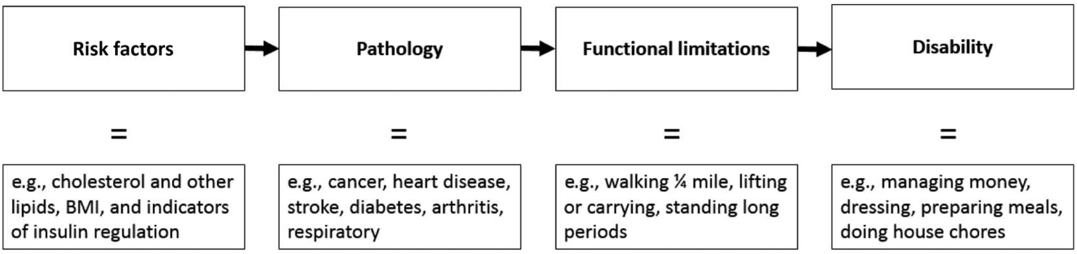

Figure 1. The disability process: Theoretical pathway leading from risk factors to disability.

2001). In addition, negative consequences of vision impairment have been studied with respect to secondary health outcomes such as hospital and emergency room utilization (Jacobs, Hammerman-Rozenberg, Maaravi, Cohen, & Stessman, 2005), falls (Crews, Chou, Stevens, & Saaddine, 2016), and hip fractures (Felson et al., 1989).

Thus, associations between vision impairment and sundry health outcomes are common, and seem to reflect the relevance of vision as an indicator of the general health status of adults as they age. As part of their Vision Health Initiative, the Centers for Disease Control and Prevention (CDC) have identified as an objective the description and characterization of the public health significance of vision loss and the relationship between vision loss and quality of life, health disparities, and comorbid conditions (CDC, 2016). In the spirit of that goal, the aim of this paper is to describe a nationally representative study that assessed how health outcomes differ by self-reported vision status.

The disability process

One potential framework for describing how vision impairment is associated with health is the disability process framework, originally proposed by Nagi (1965) and later reconceptualized by Verbrugge and Jette (1994). The framework consists of four stages that progress from (1) risk factors, through (2) pathology to result in (3) reduced functioning, and eventually (4) disability (see Figure 1).

Risk factors

In developing Nagi's (1965) model, Verbrugge and Jette (1994) defined *risk factors* as characteristics of an individual (including biological characteristics) that can affect the presence and severity of pathology and impairment. Biological indicators include cholesterol levels, body mass index (BMI), markers of inflammation (such as C-reactive protein, CRP), and indicators of insulin regulation (such as glycated hemoglobin). Accordingly, these biological factors often precede diseases and conditions that lead to functional impairment (including visual impairment), disability, and mortality. For example, glycated hemoglobin—a measure of the average amount of hemoglobin bound to glucose over a prolonged period—could serve as a preclinical indicator of diabetes, and a precursor to diabetic retinopathy, one of the most common causes of vision loss.

Several biomarkers have been associated with higher rates of mortality (Harris et al., 1999), reduced cognitive (Wilson, Finch, & Cohen, 2002) and physical (Cohen, Harris, & Pieper, 2003) functioning, and heart disease (Cesari et al., 2003), and

are generally viewed as good indicators of the health status of older people (Crimmins et al., 2005), without regard to vision status.

In a study that directly compared biological risks of older persons with clinically measured blindness and low vision with older adults with typical vision, Steinman and Vasunilashorn (2011) compared at-risk levels for nine biological markers with underlying relevance in predicting clinical manifestation of conditions commonly experienced by older adults and associated with poorer physiological functioning. In that study, older adults who were blind were found to be more likely to have high-risk levels of low density lipoprotein (LDL) cholesterol and homocysteine, and to be underweight. Thus, it was noted that differences between vision groups were likely in part to be related to diet, and could potentially be addressed by way of nutrition and diet programs aimed toward education of older people who are visually impaired.

Pathology

Pathology is described as physiological abnormalities that are labeled as disease and that presumably arise from biological as well as behavioral risk factors. The incidence of chronic conditions increases with age. Previous studies have reported that by age 65, the vast majority of individuals have multiple chronic conditions (Wolff, Starfield, & Anderson, 2002), many of which are associated with vision loss. Furthermore, older individuals who are visually impaired have more health problems than their peers with typical vision, including lower bone mineral density, higher rates of osteoporosis, depression, and diabetes (Crews et al., 2006; Ray & Wolf, 2008).

Functional limitations

Functional limitations are difficulties performing fundamental physical and mental activities used in daily life, and may include overall mobility impairment, and losses of discrete motions and strengths (Verbrugge & Jette, 1994). Functional activities act as component tasks of most daily living activities. For example, in order to successfully shop for groceries, one must have enough strength and agility in one's limbs to walk a quarter of a mile to and from one's car in the parking lot; to stoop and reach for low items on the shelf; and to lift heavier items into the cart. Each functional activity, when combined with others, makes up more complex tasks, within specific domains of day-to-day living. According to Martin and Schoeni (2014), functional limitations experienced by older adults have increased since 1997, in part due to greater rates of obesity and musculoskeletal conditions such as arthritis.

Disability

Finally, *disability* is defined as having difficulty performing activities in specific age-appropriate domains of life, ranging from personal care to household management activities. In the case of older adults, domains have traditionally consisted of activities of daily living (ADLs), such as eating, toileting, and dressing; and instrumental activities of daily living (IADLs), including managing money and preparing meals (Verbrugge & Jette, 1994). According to Martin and Schoeni (2014), disability rates among persons aged 65 and older have decreased in recent years—a

trend they attribute to increased education among the current cohort of older adults, as well as better management of some chronic health conditions. Nevertheless, disability rates increase dramatically after around age 80. Perhaps not surprisingly, limitations in daily living activities are more commonly reported among older adults with vision impairments.

The purpose of this study was to compare the health of older persons with and without self-reported vision impairments by the health dimensions described above. Such comparisons are important, because of the potential to identify points in the disability framework where older persons with vision impairments differ from those with typical vision, and to develop interventions at those points to prevent progression to later stages in the disability process.

Methods

Data

Variables corresponding to each health dimension of the disability process framework were selected for analyses from five cycles (1999 to 2008) of the National Health and Nutrition Examination Survey (NHANES IV). Within NHANES, cross-sectional data are collected biennially to form a continuous data set, which when weighted are representative of the noninstitutionalized American population, ages 2 years and older. When an inclusion criterion of age greater than 64 years was applied, a total weighted sample size of 6,693 participants remained for analysis.

NHANES is composed of four sections from which variables were selected. From the demographics section, covariates representing age, sex, race, educational attainment, and marital status at screening were drawn. The examination section provided information collected through physical exams and dietary interview components—this section included body measurements such as BMI and blood pressure. Laboratory files based on analyses of blood and urine specimens provided information about biological risk factors such as total cholesterol levels and glycated hemoglobin. Finally, a questionnaire section provided information pertaining to self-reported health and functioning.

Independent variables

Self-reported vision

A self-reported measure of vision status was assessed as the key independent variable. Respondents were asked to rate their present eyesight, with glasses or contact lenses if they regularly wore them. Participants could rate their vision as excellent, good, fair, poor, or very poor. This item was recoded into three indicator variables—respondents who said that their vision was poor or very poor made up one group, and those who rated their eyesight as fair made up a second group. Participants who rated their vision as good or excellent made up a third group, which served as the reference category.

Dependent variables

Sociodemographic covariates

Five sociodemographic characteristics of participants were assessed, comprised of age, gender, race, marital or partner status, and education. Age was analyzed as a continuous variable. Gender, race, and marital status were coded into indicator variables with "male," "white," and "not

Table 1
Descriptive statistics for sociodemographic variables by self-reported vision status (NHANES IV, 1999–2008, weighted).

Variables	Good (n = 4,916)	Fair (n = 1,169)	Poor (n = 465)	Total (N = 6,550)	Test t or χ^2	*Prob.*
Total (%)	75.1	17.8	7.1	100.0		
Age (mean years)	74.2	75.8	77.3	74.7	t = 11.8	< 0.0005
Female (%)	57.7	61.7	66.3	58.2	χ^2 = 7.1	0.04
Race						
White (%)	85.6	76.4	75.6	83.0	χ^2 = 49.5	< 0.0001
Hispanic (%)	5.0	8.9	9.7	6.1	χ^2 = 15.5	0.0009
Black (%)	6.8	11.3	10.4	7.9	χ^2 = 33.9	< 0.0001
Other (%)	2.7	3.4	4.3	3.0	χ^2 = 2.06	0.36
Education						
< High school (%)	5.8	43.4	55.5	31.0	χ^2 = 145.8	< 0.0001
High school (%)	30.7	27.9	22.5	29.6		
> High school (%)	43.5	28.7	22.0	39.4		
Married or partnered (%)	59.0	50.3	39.0	55.8	χ^2 = 41.7	< 0.0001

married or partnered" as reference categories, respectively. Education was coded as an ordered categorical variable comprised of three levels—less than a high school diploma, graduated from high school or equivalent (for example, completion of General Educational Development requirements), and greater than a high school education (see Table 1).

Biological indicators

Dichotomous variables were computed based on clinically defined at-risk levels for each biological marker. The 10 biomarkers included systolic and diastolic blood pressure, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, total cholesterol, glycated hemoglobin, two extremes of BMI (underweight and obese), fasting triglycerides, C-reactive protein (CRP), and plasma homocysteine. High and low cut-points (shown in Table 2) have been used in other studies of older adults (Crimmins et al., 2005) and have been associated with health outcomes that include disability and mortality (Alley & Chang, 2007).

Pathology

A combination of items from various sections of the NHANES questionnaire were used to create seven dependent variables representing pathological conditions commonly experienced by older people (see Table 3). Participants were asked whether a doctor had ever told them that they had arthritis, congestive heart failure, coronary heart disease, angina pectoris, heart attack, stroke, emphysema, chronic bronchitis, or cancer. Participants could state that they had or had not been told by a doctor that they had each condition. A variable representing heart problems was created, and coded in the positive direction (has heart problem = 1) if respondents confirmed that a doctor had told them they had any one of the heart problems probed. Similarly, a variable representing respiratory problems was created, and it was coded positively if the respondent said that he or she had been

Table 2
Binary logistic regression models testing the effect of self-reported vision status on biological risk indicators (NHANES IV, 1999–2008, weighted).

Indicator	At-risk cut-point	*N*	Fair vision OR	Fair vision 95% CI	Poor vision OR	Poor vision 95% CI
Diastolic blood pressure	> 90 mmHg	5,491	1.27	(0.81–1.99)	1.16	(0.63–2.15)
Systolic blood pressure	> 140 mmHg	5,491	1.13	(0.96–1.34)	1.17	(0.88–1.55)
HDL cholesterol	< 40 mg/dl	5,422	**1.33**	**(1.11–1.60)**	**1.42**	**(1.02–1.99)**
Fasting LDL cholesterol	> 160 mg/dl	1,761	0.71	(0.46–1.09)	0.91	(0.45–1.83)
High total cholesterol	> 240 mg/dl	4,138	0.83	(0.62–1.10)	0.99	(0.70–1.41)
Low total cholesterol	< 160 mg/dl	4,138	1.14	(0.87–1.50)	1.13	(0.64–2.00)
Glycated hemoglobin	$> 6.4\%$	5,511	**1.3**	**(1.03–1.64)**	**1.91**	**(1.35–2.70)**
Obese (BMI)	> 30 kg/m^2	5,499	1.05	(0.88–1.25)	1.07	(0.83–1.38)
Underweight (BMI)	< 18.5 kg/m^2	5,499	0.62	(0.33–1.20)	0.79	(0.33–1.90)
Fasting triglycerides	> 200 mg/dl	2,375	1.11	(0.76–4.61)	0.87	(0.52–1.46)
C-reactive protein	> 4.0 mg/l	5,457	1.09	(0.90–1.31)	1.11	(0.87–1.41)
Plasma homocysteine	> 15 μmol/l	4,208	**1.56**	**(1.20–2.04)**	**2.06**	**(1.43–2.96)**

Models controlled for age, gender, race, education, and marital status.
Odds ratio (OR) with good vision as the reference group; CI = confidence interval; HDL = high-density lipoprotein; LDL = low-density lipoprotein; BMI = body mass index.
Bold items indicate significance at the $p < .05$ level.

told by a doctor that he or she had emphysema or chronic bronchitis.

Hearing was assessed with an item that asked participants to pick the statement that best reflected their ability to hear. Respondents could state that their hearing was good, that they had a little trouble hearing, a lot of trouble, or that they were deaf. This variable was recoded into a dichotomous variable that compared participants who reported a lot of trouble hearing or deafness with a reference group of participants who reported little trouble or good hearing.

Table 3
Binary logistic regression models testing the effect of self-reported vision status on self-reported pathological conditions (NHANES IV, 1999–2008, weighted).

Pathological condition	*N* (models 1 and 2)	Fair vision Model 1* OR	95% CI	Fair vision Model 2† OR	95% CI	Poor vision Model 1* OR	95% CI	Poor vision Model 2† OR	95% CI
Cancer	6,420/3,731	1.07	(0.90–1.28)	1.06	(0.87–1.30)	1.10	(0.89–1.35)	1.20	(0.86–1.67)
Arthritis	6,414/3,725	**1.30**	**(1.12–1.51)**	1.20	(0.93–1.54)	**1.56**	**(1.24–1.97)**	**1.52**	**(1.11–2.08)**
Heart problem	6,429/3,735	**1.57**	**(1.30–1.90)**	**1.51**	**(1.18–1.95)**	**1.71**	**(1.31–2.22)**	**1.82**	**(1.24–2.66)**
Stroke	6,399/3,722	**1.72**	**(1.35–2.20)**	**1.68**	**(1.14–2.49)**	**2.48**	**(1.90–3.31)**	**2.00**	**(1.30–3.06)**
Respiratory	6,381/3,705	**1.47**	**(1.16–1.88)**	**1.68**	**(1.20–2.37)**	**1.97**	**(1.53–2.53)**	**2.46**	**(1.70–3.55)**
Diabetes	6,423/3,705	**1.66**	**(1.41–1.96)**	**1.63**	**(1.24–2.13)**	**1.92**	**(1.52–2.44)**	**1.71**	**(1.09–2.69)**
Hearing	6,429/3,735	1.47	(0.94–2.28)	0.84	(0.55–1.26)	**1.83**	**(1.16–2.91)**	1.68	(0.63–4.49)

* Model 1 controlled for age, gender, race, education, and marital status.
† Model 2 controlled sociodemographic and biological risk factors.
Odds ratio (OR) with good vision as the reference group; CI = confidence interval; Bold items indicate significant at the $p < .05$ level.

Finally, participants were asked whether a doctor had ever told them they had diabetes or that their blood sugar was bordering on high-risk levels for diabetes. This variable was recoded into a dichotomous variable that compared participants who had been told they had diabetes or were bordering on high-risk levels for diabetes with those without diabetes.

Functional limitations

Participants were asked whether, due to a health problem, they had difficulty performing 10 functional activities, comprised of walking a quarter of a mile; walking up 10 steps; stooping, crouching, or kneeling; lifting or carrying; walking between rooms on the same floor; standing up from an armless chair; standing for about two hours; sitting for long periods; reaching up over head; and grasping small objects (see Table 4). Respondents could report having no difficulty, some difficulty, much difficulty, they were unable to do the activity, or they did not do the activity. These items were recoded into ordered categorical variables, with respondents reporting some or much difficulty grouped together, and those reporting inability forming a second group. Participants who reported no difficulty served as a reference group.

Disability

Participants were asked whether, due to a health problem, they had difficulty managing money; doing house chores; preparing meals; getting in and out of bed; using a fork or knife, or drinking from a cup; dressing themselves; going out to movies; attending a social event; and performing leisure activities at home (see Table 5). Respondents could report having no difficulty, some difficulty, much difficulty, that they were unable to do the activity, or that they did not do the activity. Disability items were recoded into ordered categorical variables, with respondents who reported some or much difficulty grouped together, and those reporting inability forming a second group. Participants who reported no difficulty served as a reference category.

Analyses

Analyses for this study were conducted using Statistical Analysis Software (SAS), version 9.2 for Windows. All analyses were modified in order to account for the survey design and selection effects of the complex sampling used by NHANES. Basic descriptive statistics were calculated for vision status and sociodemographic covariates. Statistical tests (*t*-test or Wald ^{2}) were computed to determine statistically significant differences between vision groups.

Main analyses consisted of binary and multinomial logistic regressions to estimate odds ratios (ORs) and 95% confidence intervals (95% CIs) reflecting the likelihood of negative health outcomes among persons with self-reported poor and fair vision relative to persons with good vision. Covariates of each model were selected based on the position of dependent variables in the disability framework. For each dependent variable, two models were assessed. The first model controlled for sociodemographic covariates and self-reported vision status, whereas the second model controlled covariates within health dimensions to the left of the category being tested (see Figure 1). For example, the odds of self-reporting a diagnosed pathological

Table 4
Multinomial logistic regression models testing the effect of self-reported fair vision status on self-reported difficulty in functioning indicators (NHANES IV, 1999–2008, weighted).

			Fair vision				Poor vision			
			Model 1*		Model 2†		Model 1*		Model 2†	
Activity	*N* (models 1 and 2)		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Walk ¼ mile	6,352/3,640	Difficulty	**1.83**	**(1.49–2.25)**	**1.72**	**(1.30–2.28)**	**2.24**	**(1.67–3.02)**	**1.73**	**(1.09–2.75)**
		Unable	**2.57**	**(2.01–3.29)**	**2.01**	**(1.46–2.77)**	**5.23**	**(4.01–6.82)**	**3.93**	**(2.50–6.16)**
Walk 10 steps	6,379/3,649	Difficulty	**1.81**	**(1.52–2.15)**	**1.52**	**(1.16–2.01)**	**2.79**	**(2.00–3.89)**	**1.69**	**(1.08–2.41)**
		Unable	**2.18**	**(1.74–2.74)**	**1.53**	**(1.08–2.18)**	**4.64**	**(3.59–5.99)**	**2.81**	**(1.82–4.35)**
Stoop, crouch, kneel	6,323/3,632	Difficulty	**1.71**	**(1.43–2.05)**	**1.46**	**(1.46–3.24)**	**2.54**	**(1.91–3.39)**	**2.17**	**(1.46–3.24)**
		Unable	**2.48**	**(1.99–3.10)**	**1.92**	**(1.27–2.92)**	**6.52**	**(4.80–8.87)**	**4.24**	**(2.47–7.28)**
Lifting or carrying	6,299/3,626	Difficulty	**1.80**	**(1.54–2.10)**	**1.61**	**(1.25–2.08)**	**2.64**	**(1.99–3.51)**	**1.84**	**(1.08–3.13)**
		Unable	**2.28**	**(1.67–3.11)**	**1.81**	**(1.09–3.02)**	**5.61**	**(4.06–7.74)**	**4.43**	**(2.65–7.42)**
Walk between rooms	6,410/3,673	Difficulty	**2.10**	**(1.61–2.73)**	**2.09**	**(1.40–3.11)**	**3.98**	**(2.99–5.30)**	**3.36**	**(2.22–5.09)**
		Unable	**2.40**	**(1.55–3.73)**	1.29	(0.49–3.42)	**4.78**	**(2.93–7.80)**	2.91	(0.94–9.01)
Stand from armless chair	6,414/3,673	Difficulty	**2.03**	**(1.68–2.45)**	**1.90**	**(1.41–2.55)**	**2.99**	**(2.28–3.92)**	**2.27**	**(1.55–3.33)**
		Unable	**1.81**	**(1.24–2.64)**	**1.92**	**(1.06–3.49)**	**5.46**	**(3.65–8.17)**	**3.87**	**(2.10–7.14)**
Stand long periods	6,242/3,594	Difficulty	**1.71**	**(1.40–2.10)**	**1.51**	**(1.19–1.91)**	**2.38**	**(1.74–3.26)**	**2.18**	**(1.47–3.25)**
		Unable	**2.36**	**(1.90–2.93)**	**1.71**	**(1.24–2.36)**	**6.27**	**(4.53–8.68)**	**4.09**	**(2.53–6.63)**
Sit long periods	6,406/3,664	Difficulty	**1.65**	**(1.36–2.01)**	**1.72**	**(1.35–2.20)**	**2.39**	**(1.79–3.21)**	**2.22**	**(1.52–3.25)**
		Unable	**1.78**	**(1.04–3.05)**	1.49	(0.84–2.65)	**8.59**	**(4.76–15.51)**	**4.89**	**(2.52–9.49)**
Reach up over head	6,408/3,670	Difficulty	**1.91**	**(1.58–2.31)**	**1.54**	**(1.14–2.06)**	**2.32**	**(1.85–2.90)**	**1.51**	**(1.03–2.22)**
		Unable	**2.01**	**(1.36–2.95)**	1.64	(0.81–3.35)	**4.03**	**(2.38–6.82)**	2.07	(0.74–5.78)
Grasp or hold small object	6,421/3,675	Difficulty	**1.86**	**(1.45–2.39)**	**2.02**	**(1.43–2.85)**	**2.26**	**(1.74–2.95)**	**1.50**	**(1.05–2.16)**
		Unable	**2.75**	**(1.30–5.79)**	2.60	(0.55–12.33)	**9.23**	**(4.00–21.28)**	**5.50**	**(1.36–22.24)**

* Model 1 controlled for age, gender, race, education, and marital status.
† Model 2 controlled for sociodemographic variables, biological risk factors, and pathological conditions.
Odds ratio (OR) with good vision as the reference group; CI = confidence interval.
Bold items indicate significance at the $p < .05$ level.

Table 5
Multinomial logistic regression models testing the effect of self-reported fair vision status on self-reported difficulty in daily living activities (NHANES IV, 1999–2008, weighted).

			Fair vision				Poor vision			
			Model 1*		Model 2†		Model 1*		Model 2†	
Activity	*N* (models 1 & 2)		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Manage money	6,110/3,350	Difficulty	**2.17**	**(1.66–2.84)**	**1.65**	**(1.08–2.53)**	**4.28**	**(3.16–5.79)**	**2.81**	**(1.72–4.59)**
		Unable	**1.75**	**(1.19–2.56)**	**0.38**	**(0.17–0.85)**	**7.01**	**(4.69–10.44)**	**3.07**	**(1.29–7.29)**
House chores	6,124/3,360	Difficulty	**2.20**	**(1.79–2.72)**	1.11	(0.74–1.67)	**4.05**	**(3.27–5.02)**	**1.78**	**(1.08–2.94)**
		Unable	**1.85**	**(1.32–2.61)**	0.59	(0.28–1.25)	**8.06**	**(5.57–11.68)**	**2.95**	**(1.27–6.87)**
Preparing meals	6,088/3,358	Difficulty	**2.19**	**(1.71–2.81)**	1.02	(0.66–1.59)	**4.40**	**(3.13–6.19)**	**2.2**	**(1.15–4.19)**
		Unable	**1.48**	**(1.01–2.17)**	0.23	(0.10–0.55)	**6.35**	**(4.29–9.38)**	2.29	(0.91–5.76)
Get in or out of bed	6,416/3,454	Difficulty	**2.19**	**(1.80–2.66)**	1.10	(0.79–1.53)	**3.27**	**(2.56–4.17)**	1.05	(0.59–1.86)
		Unable	2.07	(1.06–4.03)	2.08	(0.20–22.12)	**6.23**	**(3.10–12.54)**	**9.55**	**(1.17–77.59)**
Using fork, knife, cup	6,428/3,457	Difficulty	**2.30**	**(1.71–3.09)**	1.33	(0.78–2.27)	**3.68**	**(2.70–5.02)**	**2.18**	**(1.21–9.95)**
		Unable	1.83	(0.46–7.24)	—	—	**13.34**	**(3.45–51.77)**	—	—
Dressing	6,422/3,455	Difficulty	**1.84**	**(1.44–2.35)**	0.84	(0.55–1.28)	**3.80**	**(2.92–4.93)**	**2.31**	**(1.42–3.77)**
		Unable	**2.33**	**(1.26–4.32)**	0.86	(0.21–3.56)	**9.54**	**(4.58–19.92)**	1.50	(0.13–17.68)
Go to movies or events	6,187/3,390	Difficulty	**2.11**	**(1.74–2.55)**	1.02	(0.69–1.50)	**4.40**	**(3.42–5.67)**	**2.77**	**(1.63–4.69)**
		Unable	**1.91**	**(1.27–2.89)**	0.70	(0.32–1.53)	**8.72**	**(5.91–12.87)**	**6.12**	**(2.83–13.22)**
Attend social events	6,185/3,390	Difficulty	**2.44**	**(1.99–3.00)**	1.27	(0.80–2.03)	**4.67**	**(3.74–5.82)**	**3.01**	**(1.78–5.08)**
		Unable	**1.59**	**(1.04–2.41)**	0.59	(0.27–1.30)	**7.72**	**(5.33–11.19)**	**2.64**	**(1.08–6.45)**
Leisure at home	6,416/3,453	Difficulty	**3.11**	**(2.27–4.25)**	**1.86**	**(1.17–2.96)**	**8.24**	**(6.21–10.93)**	**5.91**	**(3.24–10.77)**
		Unable	2.34	(0.91–5.99)	0.60	(0.19–1.90)	**11.47**	**(5.25–25.09)**	**4.99**	**(1.48–16.81)**

* Model 1 controlled for age, gender, race, education, and marital status.
† Model 2 controlled sociodemographic covariates, biological risk factors, pathological conditions, and functional difficulty.
Odds ratio (OR) with good vision as the reference group; CI = confidence interval.
Bold items indicate significance at the $p<.05$ level.

condition was tested with control for sociodemographic covariates and biological risk factors. This hierarchical covariate control structure was used to assess the relative impact of preceding health dimensions on the dependent variables, compared to crude analyses, controlling only for sociodemographic covariates.

Results

Table 1 displays unadjusted percentages and means of selected sociodemographic covariates by self-reported vision status. More than three-quarters of the sample reported having good or better vision, whereas 18% reported fair vision and 7% self-reported poor vision. The mean age of the sample was 74.7 years. On average, participants who reported poor vision were older (μ = 77.3) than those with fair vision (μ = 75.8), and those with good vision (μ = 74.2). The majority (58%) of the sample was female, and proportions of female participants were greater in fair (62%) and poor (66%) vision categories, compared to participants with good vision (58%).

The majority of the sample was white (83%), whereas 8% were black, 6% were non-white Hispanic, and 3% reported some other race. Disproportionately low percentages of blacks and Hispanics reported having good vision (7% and 5%, respectively). The majority (69%) of the sample reported having attained a high school diploma or more education, although only 57% with fair vision and 45% with poor vision had attained as much education, compared to 74% with good vision. Finally, the majority of participants (56%) reported being married or partnered. Those with poor vision were least likely to report being married or partnered (39%), compared to 50% with fair vision and 59% with good vision.

Table 2 presents results of binary logistic regressions conducted to determine the relative odds that persons with fair and poor self-reported vision would have high-risk levels of the 10 biological risk indicators relative to those with good or better vision status. After controlling for sociodemographic covariates, having both fair and poor self-reported vision was statistically associated with at-risk levels of HDL cholesterol, glycated hemoglobin, and plasma homocysteine.

Table 3 shows odds that older persons with fair or poor self-reported vision report a diagnosis of each pathological condition relative to older persons with good vision. Model 1 includes odds ratios controlling for sociodemographic covariates, and model 2 controls for sociodemographic and biological risk covariates. With the exception of cancer, arthritis, and hearing impairment, persons with fair vision, on average, were more likely than persons with good vision to report having all other impairments. Older persons with poor vision experienced greater odds compared to those with good vision of reporting all pathological conditions except cancer, after controlling for sociodemographic and biological risk covariates.

The ORs and 95% CIs representing difficulty and dependence in each functional activity, by fair and poor vision groups, relative to good vision, are displayed in Table 4. Model 1 controls for sociodemographic covariates; model 2 controls sociodemographic covariates, biological risk factors, and pathological conditions. Without exception, persons with fair and poor vision on average had greater odds of reporting difficulty with all functional

activities, compared to older persons with good vision, even after accounting for covariates.

Table 5 shows ORs and 95% CIs representing difficulty and dependence in each daily living activity, by fair and poor vision groups, relative to good vision. Model 1 shows ORs with controls for sociodemographic covariates; model 2 shows ORs after controlling sociodemographic covariates, biological risk factors, pathological conditions, and functional difficulty.

After controlling for other health dimensions, older persons with fair vision were more likely to have difficulty with few of the daily living activities. Significant differences between persons with fair vision and those with good vision were found for difficulty managing money and doing leisure activities at home.

In contrast, persons with poor vision were more likely to experience difficulties with most daily living activities. For example, older persons with poor vision were more than twice as likely as their counterparts with good vision to report difficulty preparing meals; using a knife, fork, and cup; and dressing. Older persons with poor vision were also more likely to report being unable to perform most daily living activities.

Discussion

The purpose of this study was to compare older adults with fair and poor self-reported vision status with those who reported good vision on the basis of four health dimensions that make up a theoretical pathway to disability in later life. According to Verbrugge and Jette (1994), biological factors are among many personal risk characteristics that represent the first stage leading to disability, via pathology and functional decline. Understanding how older people with vision impairments differ from those with typical vision, with respect to these health dimensions, is an important starting point for understanding how health disparities between vision groups could precipitate relatively worse health outcomes for older persons with vision impairment.

Observed disparities across health dimensions could derive from at least two potential explanations. First, disparities among vision status groups may originate as a result of disability—that is, limitations in daily activities that could lead to changes in diet, health maintenance, and activity levels that often follow the onset of vision impairment (Crews & Campbell, 2004). Functional losses in general inherently suggest that older adults who experience them will be less physically active. Some specific measures of ADLs and IADLs that are typically used to quantify disability in older people place direct emphasis on activities that would influence the dietary choices of persons who could not perform them independently (such as the ability to eat independently, prepare meals for themselves, or to shop for groceries without assistance). Consistent with this view, the results of this study indicated that older adults with vision impairments were more likely to report difficulties with an array of daily living activities, including preparing meals and using utensils to eat. Similar difficulties over a long enough period of time would likely affect other aspects of an individual's health, starting by reducing physical activity and dietary quality and, subsequently, exerting negative

influence on specific biomarkers that may reflect the individual's dietary practices and activity levels.

Second, health disparities may be a reflection of primary pathologies and conditions that often precede vision loss and that are indirectly related to poor vision status. For example, with respect to disease, results of this study suggest that poor self-reported vision status is associated with cardiovascular problems and diabetes. In this case, disease may precede or even cause vision loss.

Thus, the association between vision status and health outcomes is complicated because it is often difficult to determine the directionality of the relationship—that is, to sort out the extent to which vision impairment causes changes in biomarkers that often precede chronic pathology, functional decline, and disability versus the extent to which chronic pathology may lead to vision loss. Ultimately, it is likely that disparities in health outcomes can be explained by both mechanisms. Unfortunately, the use of cross-sectional data was limiting in the current study, because it did not provide the opportunity to assess the order of these important changes. Therefore, future studies should employ a more rigorous longitudinal data and design to take into consideration the order of key events, and to make a more powerful assertion of causality.

Another potential limitation of this study resulted from the choice of Nagi's (1965) disability framework as the basis of analyses—specifically, that it does not take into account environmental factors that can often be modified to address functional limitations and disability. Especially for people with vision loss, adapting the environment and making modifications may often delay or prevent disability. Under this circumstance, the condition of vision impairment may still exist, but is no longer disabling when the environment is modified (for example, with high-contrast, large print documents, large print signage, proper lighting, and a font that is sans serif) or when alternative methods for addressing everyday needs are available, such as food delivery from the supermarket. A more current model of the disability process—the International Classification of Functioning, Disability, and Health (ICF)—includes environmental factors as potential mediators of associations between functional impairment and disability outcomes (Ustun, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003). Therefore, ICF could be used in future research to assess models that are more comprehensive than those described here.

Results of this study point to important differences between older persons with vision impairment and those with typical vision. Previous studies, as well as the evidence presented here, suggest that effective vision rehabilitation programs that target older adults with vision impairments would need to address chronic conditions, functional difficulties, and disability in daily living activities, as well as vision loss, in order to maximize the effect of services. This more comprehensive approach to vision rehabilitation might include teaching techniques for coping with vision-related disability, and providing assistive technology and home modifications that are specifically designed to address difficulties with daily living activities. Similarly, with respect to mobility issues, current training that is available through the Older Blind

Independent Living program administered through the Rehabilitation Services Administration may be an appropriate medium for introducing older adults with vision impairments to physical exercise regimes that are effective for countering age-related losses in upper and lower limbs. Orientation and mobility specialists can also provide useful strategies for safe travel in both residential and community environments. In addition, physical and occupational therapists could provide training and exercise programs, and vision rehabilitation specialists could be involved in home assessments and modifications that are specifically adapted to meet the unique circumstances of older people with visual impairments.

The development of effective therapies aimed at addressing the diverse needs of a growing number of older adults who are blind or visually impaired will likely depend on the participation of professionals from across a spectrum of fields. Programs that hold the greatest potential in vision rehabilitation would explore dynamic interactions between the abilities of older adults and their surroundings. It is clear, given projections of a growing number of older individuals with vision impairments, that practitioners who are interested in improving the health and functioning of older adults will need to become increasingly aware of issues related to medical, functional, and rehabilitative aspects of vision loss. This awareness can be achieved by continuing rigorous research and dissemination of findings, and by assuring adequate funding for rehabilitation programs that address factors across health dimensions.

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